An Integrated Patient Journey Mapping Tool for Embedding Quality in Healthcare Service Reform

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The healthcare sector is a highly regulated environment that is subject to numerous constraints. Standards around medical protocol, medical device certification, and data protection ensure that the wellbeing and privacy of patients is protected during all encounters with the healthcare system. However, a gap has opened up between the need to meet these constraints, improve performance, and also deliver good patient experience. For example, the medical protocol for hypertension during pregnancy establishes a set of clinically validated treatment guidelines, but does not consider the unique nature of patient experience. We assert that design research principles can be used to create visual tools that pay homage to these constraints and performance improvement goals without compromising patient experience. In this paper, we describe such a tool that has been developed during a healthcare project using a human-centred design research approach. The integrated tool for patient journey mapping addresses the shortcomings of existing methodologies by supporting multidisciplinary practitioners in designing healthcare solutions that meet the demands of existing constraints, performance improvement, and patient experience. In addition, we document how patient journey maps were used on the project to facilitate collaboration among a team of multidisciplinary stakeholders.

Keywords: healthcare service, modelling, design science, patient experience

1. Introduction

In the recent past, considerable investment has been directed towards healthcare service reform strategies to deal with the growing challenges faced by the sector e.g. scarce funding, medical inflation and the aging population. For example, since the introduction of the Health and Social Care Act in 2012, the UK government will have invested roughly £1.5 billion in introducing widespread performance improvement reform to NHS services (King's Fund, 2015). Initiatives such as process redesign and health information systems implementations are often targeted with the aim of increasing the efficiency and quality of healthcare delivered while simultaneously reducing waiting times (Pickles et al., 2008). Health service reform initiatives have traditionally focused on two areas: performance improvements and regulatory constraints, with patient experience consequently receiving less attention (Bate and Roberts, 2006; Pickels et al., 2008). An efficient and compliant process does not necessarily mean a good experience will be delivered; for instance, a patient might receive an appointment quickly but their overall experience will be poor if (for example) the waiting room is overcrowded. In making difficult decisions around the investment of scarce funds, it is, therefore, essential that patient experience is not overlooked in healthcare service reform. As pointed out by Yusof et al. (2007) and Abugabah & Alfarraj (2015), unless there is a fit

between technical, organisational, and human issues, service reform efforts can deliver subpar results. This finding is reinforced by studies which show the impact of patient experience on measures of clinical effectiveness and patient safety (Doyle et al., 2013).

Patient experience should be a principal goal along with delivering performance improvement and meeting constraints. This raises a formidable challenge as patient experience is not typically considered in healthcare reform. At the same time the healthcare sector being a highly regulated environment demands that regulatory constraints are taken into consideration in any service reform initiatives. Examples of the constraints that ought to be considered when addressing patient experience include medical protocol and clinical guidelines (e.g. The National Institute for Health and Care Excellence guidelines), ethical standards (e.g. Good Clinical Practice), medical device certification (e.g. FDA approval and CE Marking), and data protection (e.g. General Data Protection Act). All these constraints aim to safeguard patient wellbeing and privacy. Therefore we suggest that wider service reform and any methodology adopted ought to consider the following three healthcare service reform goals in tandem: performance improvements, regulatory constraints, and patient experience. Otherwise key requirements may be overlooked leading to problems later on – such as poor performance or poor experience leading to low usage / boycott, ineffective decisions by healthcare professionals (Abugabah & Alfarraj, 2015; Doyle et al., 2013).

While methods are available for addressing each of the health service reform goals separately, to the best of our knowledge there is no single healthcare modelling tool currently in existence that addresses all three goals collectively and effectively. In this paper we seek to address this gap by proposing a visual tool called the *Integrated Patient Journey Mapping Tool* (IPJM) that is inspired by the concept of journey mapping but simultaneously considers the factors of performance improvement, regulatory constraints, and patient experience. Section 2 offers a conceptual foundation for a patient journey mapping tool by reviewing literature. Section 3 then describes how design research methods have been used in designing and evaluating the proposed IPJM patient journey mapping tool. Section 4 explains the form of the tool. A discussion around the merit of IPJM is outlined in Section 5, before bringing the paper to a conclusion in Section 6.

2. Conceptual Foundation for the Integrated Patient Journey Map

Pickels et al. (2008) provide a framework for healthcare service reform and improvement that addresses performance, regulatory constraints, and patient experience goals using the following components of good design: Functionality, Engineering, and Aesthetics of Experience. Functionality aims towards designing for improved performance using evidence-based practice, pathways and process design. Engineering looks at designing for improved clinical governance, standards and safeguards for patients (i.e. protocols, regulations, staff training). Finally, Aesthetics of Experience focuses on designing for improved human experiences through patient empowerment, patient choice, and the provision of information.

[See Figure 1]

However, while some methods for improving performance and managing regulatory constraints are relatively well established in the healthcare sector (e.g. process mapping, service blueprinting, etc.), methods for enhancing patient experience are less entrenched (Bate and Roberts, 2006; Pickels et al., 2008). Section 2.1 aims to provide insights into the nature of patient experience and how it contributes to better healthcare service outcomes. Meanwhile, section 2.2 then looks at methods which can be used to gather requirements around patient experience. The field of design research can offer valuable insights into how an artefact may be constructed in order to provide utility in addressing these real world concerns.

2.1. What is Patient Experience?

According to Doyle et al (2013, pg. 1) and Coulter et al (2009), patient experience is increasingly recognised as one of the three "pillars of quality in healthcare" alongside clinical effectiveness and patient safety. Initiatives focused on enhancing patient experience have also been shown to lead to better level of quality overall. For instance, a systematic review of 55 studies conducted by Doyle et al. (2013, pg. 1) shows that patient experience was positively associated with patient safety and clinical effectiveness "across a wide range of disease areas, study designs, settings, population groups and outcome measures". In addition, patient experience is also positively associated other indicators such as health outcomes, healthcare resource use, and medication and treatment adherence. Similarly, Manary et al. (2013) point toward studies which demonstrate that patient experience is an integral component of service quality. Consequently, the authors recommend that increased efforts should be directed towards this area to increase service quality overall.

Patient experience is formed during the moments when the operation (health service) and consumer (the patient) meet. According to Johnson and Kong (2011, pg. 8), customer experience can be defined as a customer's "personal interpretation of the service process and their interaction and involvement with it during their journey or flow through a series of touch points". Similarly, Zomerdijk and Voss (2010, pg. 68) state that "experiences are constructed by customers based on their interpretation of a series of encounters and interactions designed by a service provider". Providers cannot directly offer an experience and instead they must provide the foundational basis for customers to derive their own experiences. As a result, the service quality perceived by the customer is based on their feelings / judgement on the service quality, their experience, and the perceived benefits; this is distinct from operational service quality which looks at whether the service was delivered to its predefined specification (Johnson and Kong, 2011).

Doyle et al. (2013) assert that patient experience consists of two aspects: rational and functional. The rational aspect concerns 'interpersonal aspects of care' such as clinicians' ability to treat patients with respect and compassion, to empower patients (i.e. allowing them to care for their own health through the provision of information), and to engage patients and

the family members in the decision making process. The rational aspect also concerns patients' expectations that clinicians will act in the best interests of the patient and remain transparent in the event that anything goes wrong. Meanwhile, the functional aspects looks at the patient's basic expectations about the healthcare service including concerns such as the effectiveness and efficiency of healthcare delivery, and the cleanliness and safety of the healthcare environment. In essence, as stated by Bate and Robert (2006, pg. 309), patient experience is what a patient "thinks, feels and says about the experience of a service, process or product he or she has encountered". What is noteworthy is the lack of attention given in the academic discourse to the emotional aspects of the patient experience.

2.2. Methods for Mapping Patient Experience

Patient experience has often been overshadowed in healthcare service reform initiatives by the need to drive performance improvements and meet regulatory constraints. In light of this disparity, this paper looks at methods to provide insight into the functional, rational *and* emotional nature of patient experience and how they could be integrated with methods for improving service performance and managing constraints. These methods are largely inspired by the field of human-centred design in which the user perspective is seen as a central component to the design process alongside technical and functional requirements (Maguire, 2001; Zomerdijk and Voss 2010). The limitations of these methods are also considered in order to guide the development of our modified tool, the Patient Journey Map.

2.2.1. Journey Maps

Journey maps are used to depict the healthcare service from the perspective of the patient (Trebble et al., 2010; Trebble and Hydes, 2011; Zomerdijk and Voss, 2010). This is based on mapping a consecutive series of 'touch points' between the patient and the service where patient experience is actively shaped (Bate and Roberts, 2006; Bessant and Maher, 2009; Zomerdijk and Voss, 2010). The resulting visual tool incorporates both the physical (functional aspect of patient experience) and emotional (rational aspect of patient experience) journey with the aim of capturing patient behaviour, feelings, motivations and attitudes across the episodes of care. Journey maps go beyond the static view of other service design methods by illustrating the relationship between the customer and the service organisation as dynamic and ubiquitous within the system (Zomerdijk and Voss, 2010). They also helps to visually externalise knowledge and insights around patient experience, and promote empathy towards patient groups by placing them at the heart of the modelling process. As stated by Hostyn (2011) "Journey maps promote emotional contact with insight, distilling research into a concise, visually compelling story of the customer's experience".

In addition, lean thinking principles can be applied to patient journey maps to eliminate non-value adding care and waste, improve clinical management, and increase focus on value adding care from the perspective of the patient and staff (Mould et al., 2010; Trebble et al., 2010; Trebble and Hydes, 2011). The use of lean thinking approaches is not without some

controversy as some see the dual aim of improving patient experience and lean process improvement as working against each other (Waring and Bishop, 2010).

There are certain limitations associated with journey maps however. Given the complexity and high number of interdependencies that exist within many services, it can be challenging to design patient journey maps that are both comprehensive and accessible. Mould et al. (2010) discuss four mediums which can help make journey mapping more accessible to multidisciplinary teams of stakeholders: post-it notes (accessible but hard to compare), text box flow chart (highly detailed but complex), pictorial icons (simplified, but large maps are hard to absorb), stylised icons HTML (provides a high-level view and drill down for sub pathway maps). However, journey maps fail to adequately consider the regulatory constraints associated with healthcare service reform, and therefore the impact of constraints such as medical protocol is not included.

2.2.2. User Personas

User personas offer a method for personifying the requirements gathering process and directing increased attention towards patient experience. User personas involve creating caricatures of user groups in order to help design teams in better understanding the mental model of these groups i.e. their "expectations, prior experience and anticipated behaviour" (LeRouge et al., 2011, pg. 253; Maguire, 2001). Caricatures are developed to categorise groups of target users and personify user groups i.e. through the inclusion of information such as name, picture, personal background, and goals. User personas can then be employed to make design decisions and evaluate design solutions according to the unique needs of each persona. This also stimulates creativity around how to dynamically address user needs across different scenarios (Maguire, 2001). LeRouge et al. (2011, pg. 251) state that user personas address the limitations of common modelling tools such as UML diagrams by integrating the conceptual model of users, their "cognitive structures and present behaviour that drive health care thinking, future behaviour and demand".

Hosono et al. (2009) put forward a methodology for persona centric design where personas of users and other stakeholder are applied to service modelling. The methodology looks at the interactions between these defined personas and the service, with the aim of minimising the gap between the designed service quality and the quality level expected by user groups. Quantitative and qualitative methods are employed to collect data from target users around quality factors and values, with this data then clustered to form personas. Each persona is attributed a list of values and associated use cases, and the service boundary is defined. An analysis of the defined personas is then undertaken to help prioritise quality factors and generate requirements to guide in service design (Hosono et al., 2009). This methodology is also useful for comparing the quality factors that are important to service providers with those that are important to service receivers. However, similar to journey maps, user personas do not consider regulatory constraints or performance goals related to healthcare service reform and their scope is limited to the area of patient experience. Another limitation of user personas is that given the subjective nature of experience there is a risk that assorting a

generalised set of values across a limited number of personas can result in the loss of useful detail.

2.2.3. Storyboards

Storyboards are a "short graphical description of a narrative" where a series of images are employed to represent the user's interaction with a system and the associated system output (Maguire, 2001; Truong et al., 2006, pg. 12). Storyboards help visualise the scope, sequence, and structure of a patient's interface with the healthcare service by modelling the context and key touch points where patient experiences are created. The method is widely used in systems development for designing user interfaces prototypes, and more recently storyboard have been applied to the service domain for process modelling e.g. Ritz-Carlton (Saco and Goncalves, 2008). Part of the reason for the growing popularity of storyboards is that they provide a resource efficient solution for helping design teams to generate and refine requirements, and gain feedback from users. In addition, storyboards offer a useful complement to user personas by creating a dynamic representation of the defined personas to make them more engaging (Maguire, 2001; Sutherland & Madden, 2010).

Based on an empirical study involving storyboard professionals and novices, Truong et al.'s (2006) found that there were five significant attributes that influence the effectiveness of storyboards: level of detail, inclusion of text, inclusion of people and emotions, number of frames, and portrayal of time. But while it is possible to convey a lot of information through the presentation of a sequence of images, storyboard can still lacks detail of process maps. Storyboards are also not suitable for documenting large volumes of requirements around regulatory constraints and performance goals, which are important concerns for all healthcare service reform initiatives.

The next section looks at the approach undertaken by the authors in designing the IPJM patient journey mapping tool. The journey mapping approach has been developed for use on a pilot research project called Leanbh[1] which aims at providing remote healthcare monitoring to expectant mothers to improve the detection and treatment of hypertension during pregnancy. Examples of important constraints faced in the Leanbh project included protocols around managing the hypertensive disorders of pregnancy, the Data Protection Act, ethical guidelines, and FDA / CE mark certification. In ensuring a scientific basis to the construction of the modelling tool a Design Science approach was followed.

3. The Approach to Designing the Tool

The practice of design and the science of design are both problem solving activities whose differences lie in their contributions to the body of design knowledge. The prime focus of design practice is *artefact construction* through applying existing knowledge, while design science aims at *knowledge generation* through artefact construction or observation (Niehaves, 2007; O'Raghallaigh et al., 2011). When undertaking design research (which includes

[1] http://www.infantcentre.ie/research/mobilising-perinatal-healthcare-2/leanbh-project/

elements of both design practice and design science) abstract design knowledge should be seen as the research end result, while the creation of any instantiations based on it is an intermediary result [after: Goldkuhl & Lind (2010)]. The creation of instantiations (which happens in the design practice element of the research) is therefore an exploratory empirical part that justifies the abstract design knowledge (which emerges from the design science element of the research). In other words, design science receives its empirical grounding from design practice, but at the same time design practice receives it theoretical grounding from design science.

We, therefore, as per O'Raghallaigh et al. (2011), divide our approach into two distinct design activities separated by their degree of abstraction – see Figure 2. First, design science is focused on *identifying* and *generating abstract knowledge* to guide the design of the Patient Journey Mapping tool. The principal output from this design activity is the foundational knowledge (mainly coming from literature) guiding, explaining and justifying an approach to undertaking healthcare reform and especially using practitioner focused tools. Second, design practice is focused on *using abstract knowledge* to design and evaluate successive prototypes of the IPJM p*atient journey mapping* tool. This design activity produces situational knowledge generated from observing those using the tool and examining the models they produce using the tool. In the case of this research, the design science and design practice activities are tightly integrated whereby output from one influenced the other (Goldkuhl & Lind, 2010).

[See Figure 2]

In Table 1 we outline briefly a sample of the methods through which the prototype has to date been evaluated.

[See Table 1]

The intention going forward is to engage with potential user groups (i.e. clinicians and healthcare executives) to evaluate the prototype further and determine its acceptability across different contexts i.e. when and how it will be used.

4. The Form of the Tool

In this section, we describe the IPJM patient journey mapping tool prototype, a visual tool that bridges the gap between performance improvement, regulatory constraints, and patient experience. Firstly, the ontology upon which the modelling tool is based on is described, before explaining the form of the tool itself. The prototype combines elements from patient experience modelling tools such as journey maps, user personas, and storyboarding, and seeks to address the limitations inherent in each method.

4.1. Patient Journey Map Ontology

An ontology was first developed to conceptualise the patient journey and promote a shared understanding of the problem domain using a common vocabulary (O'Raghallaigh et al., 2011). The ontology aims to capture the key elements of the journey, the underlying structure, relationships between elements, and implicit rules that govern reality (Osterwalder, 2004). It provides the foundational basis for the modelling tool by outlining the context in which the patient journey transpires. This helps facilitate communication between stakeholders and enhances the validity of any modelling tools based on the constructs. The Patient Journey Mapping ontology depicted in Figure 3 is informed by the literature and was developed based on qualitative research involving a multidisciplinary team (including designers, technical staff, and clinicians), field research undertaken in Cork University Maternity Hospital, and desk research of supporting sources such as medical protocol.

[See Figure 3]

The ontology is split into three main areas: the *Patient Persona, Medical Timeline, and Medical Pathway*. Firstly, the *Patient Persona* provides a characterisation of the user group under consideration (e.g. an expectant mother that is at risk of hypertension and goes on to develop pre-eclampsia[2]), and is inextricably linked to all components of the ontology. The *Medical Timeline* adds a temporal aspect to the episode of care for the persona by dividing care across a defined timeframe i.e. weeks of pregnancy. Meanwhile, the *Medical Pathway* describes the consecutive events or steps in the episode of care (Trebble et al., 2010), and consists of eight subcomponents which are defined and described in Table 2. Within the *Medical Pathway*, each *Encounter* is divided into *Tasks*, and these tasks are then further subdivided into *Goals*, *Constraints*, and *Actors.* Encounters are also linked to the *Emotional Journey*, *Physical Journey*, and *Device Touch Points* associated with the episode of care.

[See Table 2]

4.2. Patient Journey Map Template

Once the ontology was complete, we iteratively designed and evaluated an instantiation of the ontology in the form of a Patient Journey Mapping Tool. This led to the development of the IPJM modelling tool. An example of a base template, constructed iteratively based on the above components, can be seen in Figure 4. The Patient Persona is situated on the left side of the template, with the Medical Pathway and its components positioned in the centre, and the Medical Timeline displayed horizontally on the top of the template. Goals, Constraints, and Actors are listed within the Tasks component.

[See Figure 4]

[2] Pre-eclampsia is a hypertensive disorder of pregnancy categorised by high blood pressure (>140/90), the presence of protein in urine, and other associated symptoms such as headaches, and oedema http://www.mayoclinic.org/diseases-conditions/preeclampsia/basics/definition/con-20031644.

Essentially, the modelling process involves a multi-disciplinary team of stakeholders working together to populate the template. Post-it notes are used to describe elements of the healthcare service and position these within the six levels of the template i.e. mapping the flow of touch points within *Encounters*. This allows the Patient Journey Map to be easily modified by removing existing post-it notes, or refining their contents and position. Different coloured markers can also be used to connect and codify post-it notes, or indicate where changes need to be made to the template based on contextual requirements.

The next section discusses the strengths and limitations of the IPJM patient journey mapping tool as a modelling tool for healthcare service reform based on the experiences of the Leanbh project.

5. Discussion of Preliminary Evaluation

This section sets out to document early signs of the IPJM's effectiveness as a modelling tool based on a critical analysis of what worked and didn't work in the given project. Further analysis and evaluation of the modelling tool will be conducted in the future and reported in further papers. The effectiveness of the modelling tool is evaluated according to the six principles outlined in O'Raghallaigh et al. (2011) on why visual tools work in supporting a multi-disciplinary design team (see Table 3):

[See Table 3]

Firstly, IPJM supports stakeholders in mapping and testing models that considers Doyle et al.'s (2013) three pillars of healthcare quality: patient experience, performance improvement, and regulatory constraints. This is achieved through the use of design science methods such as journey mapping, user persona and storyboards for graphically externalising key domain knowledge. IPJM also promote creative thinking around service reform goals and foster dialogue among stakeholders and designers, potentially leading to better solutions overall. In addition, the ontology behind the IPJM places constraints on the team, while also allowing the modelling tool to be easily adapted to different specialities i.e. oncology, or cardiology. The accessibility of the IPJM means that it can become a valuable boundary object for discussions between multi-disciplinary teams of stakeholders. For instance, the IPJM enables ideas to be shared, interrogated, and visually externalised both at an individual and group level (O'Raghallaigh et al., 2011). The use of mediums such as post-it notes means that the template is easy to use and modify as well. Thus the template can be used as a cornerstone for modelling healthcare service reform where stakeholders collaborate to derive a shared understanding and reach a collective agreement on requirements.

[See Table 4]

However, there are limitations inherent in our modelling tool (see Table 5). Firstly, not all members of the multi-disciplinary team were equally committed to using the template for

modelling the problem domain and gathering requirements. This is a key concern as it transpired later that there was a link between the involvement of stakeholders during the modelling process and their understanding of and engagement with the project overall. Therefore, future versions of the modelling tool will need to consider how best to engage practitioners from different backgrounds. Another limitation of the modelling tool is that a large sized display is required to ensure that all components are visible and legible. During the project, we experimented with different display dimensions and orientations to see how template space could be maximised, before deciding on an A2 portrait format for printing. However, going forward it may be necessary to consider whether certain elements need to be reduced in size or removed to ensure that the tool can be displayed more easily across a variety of mediums and spatial dimensions.

Another limitation of the IPJM is that it does not make explicit reference to Key Performance Indicators (KPI) such as throughput and waiting times, or other metrics such as productivity and cost efficiency. While incorporating this data in the tool would be useful, there is a risk is that increasing the level of detail any further would compromise its accessibility. Similarly, the service boundary of the tool is defined to present a high level view of the healthcare system. As a result, it may be difficult to capture some of the inherent complexity in the system and any significant diversions from the traditional pathway i.e. when a patient transfers hospitals. The tool can be adapted according to the unique context in which it is used in order to address any key elements that are missing; however, in the future a more interactive version of the tool could be developed to offer a more complete perspective of the healthcare system i.e. a software program that allows users to drill down into sub-pathways.

[See Table 5]

6. Conclusions

In order to deliver robust improvements through healthcare service reform, it is essential that the three pillars of quality (performance, regulatory constraints, and patient experience) are considered in parallel. However, to date, patient experience has traditionally received less attention than performance and regulatory constraints goals, which has consequently led to subpar results overall. In this paper, the authors address the gap in current practice using a design research approach. Firstly, an ontology was developed for modelling healthcare service reform. This subsequently resulted in the development of a modelling tool called the IPJM patient journey mapping tool which addresses Doyle et al.'s (2013) three pillars of healthcare quality in tandem. A preliminary evaluation of the IPJM Patient Journey Map indicates that it offers a structured means of visually externalising service reform and facilitating collaboration between a multi-disciplinary team. In addition, the modelling tool becomes a boundary object for discussions around how to improve healthcare services in a holistic manner. Nevertheless, limitations associated with the tool are also identified such as varying engagement across stakeholders. These will aim to be addressed and evaluated further in future publications.

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Tables

Table 1: Examples of Evaluations of the Patient Journey Map Prototype

Type	**Brief Description**	**Purpose of Activity**
Work Group	Four six-hour workshops involving a multidisciplinary group of stakeholders. The workshops focusing on deriving requirements for a connected health antenatal system that would monitor the wellbeing of expectant mothers across different settings such as the antenatal clinic, GP practice, and expectant mother's home. The core multidisciplinary team consisted of eight people including two clinicians, three system developers, an information architect, business analyst, and head facilitator. The tool was first explained by the head facilitator and was then used as a centrepiece for discussions around the proposed system.	Exploratory design of the service reform modelling tool
Analysis of Supporting Sources	A range of sources were utilised to ensure that the IPJM considered performance improvement, regulatory constraints, and patient experience goals. This involved analysing best practices around managing the patient pathway using sources such as the NICE guidelines for managing hypertension during pregnancy. In addition, information requirements were investigated based on the Health Service Executive's maternity health record, and Data Protection Act guidelines around healthcare research. These artefacts helped inform the prototype design process and assess whether or not it was an accurate representation of real world practice.	To evaluate the ability of the prototype to represent the current best practices.

Table 2: Components of the Medical Pathway

Components	**Description**
Encounters	Maps the flow of touch points across different settings (i.e. patient's home, GP clinic, or emergency room) where healthcare services are delivered and patient experience is derived.
Task	Details the tasks undertaken by each actor in the healthcare service i.e. measuring the patient's blood pressure or registering appointments.
Goals	Comprises of the desired outcomes that actors aim to deliver when carrying out tasks i.e. clinical, operational, administrative goals.
Constraints	Outlines the constraints such as treatment guidelines based on medical protocols, governance, safety and clinical guidelines.
Actors	Includes all practitioners involved in the delivery of the healthcare services such as: doctors, GPs, clinical researchers, and secretaries.
Emotional Journey	Shows how a patient's experience may change as they move through the pathway, using a trend line to depict their emotional state i.e. elation, or despair.
Physical Journey	Uses storyboarding to represent the touch points between the patient and the healthcare service across the timeline.
Device Touch Points	Lists the technological solutions utilised by the different actors (i.e. doctor, GP, patient) at each touch point.

Table 3: Principles for Evaluating the Effectiveness of Modelling Tools (Adapted from O'Raghallaigh et al., 2011)

Principle	**Citations**
(1) Supports the team in designing and testing of models	Avital, Boland and Lyyinen (2009); Rittel and Webber (1973), Conklin (2006); Römer, Leinert, and Sachse (2000); Fiol and Huff (1992)
(2) Supports the team in designing and testing of models	Römer, Leinert, and Sachse (2000); Fiol and Huff (1992); Nakakoji, Yamamoto and Takada (1999); Nickerson et al. (2008); Bruner (1996); Cox (1999); Cox and Brna (1994); Jonassen (2003); Larkin and Simon (1987); Tversky (2002); Arias et al. (2000); Engelbart (1995); Jonassen (1992); Norman (1994)
(3) Amplifies 'talk back' from the models to the team	Nakakoji, Yamamoto and Takada (1999); Jonassen (2003); Normal (1994); Jonassen 91994); Schön (1983); Nakakoji and Yamamoto (2001); Nakakoji et al. (2000)
(4) Applies ontological constraints on the models of the team	Cox and Brna (1994); Jonassen (2003); Jonassen (1992); Nakakoji et al. (2000); Suthers (2003); Polich and Schwartz (1974)
(5) Supports a collaborative approach to modelling	Conklin (2005); Nakakoji, Yamamoto and Takada (1999); Arias et al. (2000); Suthers (2003); Fischer (2005)
(6) Must be easy to use and easy to modify	Arias et al. (2000); Fritscher and Pigneur (2010); Resnick et al. (2005)

Table 4: Strengths of IPJM

Strengths	Description
Balances the pillars of healthcare quality	Considers performance, regulatory constraints, and patient experience in tandem.
Externalises domain knowledge	Allows stakeholders to externalise their domain knowledge and build a shared understanding.
Stimulates creative thinking	Facilitates dialogue between designers and different stakeholders around developing creative solutions.
Accessible	Easy for multi-disciplinary stakeholders to understand, use and modify
Adaptable	Can be adapted to the requirements of different specialities.

Table 5: Limitations of IPJM

Limitations	Description
Varying engagement across stakeholders	Some stakeholders were more committed to using the IPJM than others.
Template size	To maximise legibility, the IPJM was printed in A2 portrait format.
Doesn't include data on KPIs/metrics	Does not explicit reference to data on indicators such as waiting times, or productivity.
High level perspective of health system	Difficult to capture some of the complexity and diversions in the healthcare system.
Limited interactivity	Does not allow the user to drill down into sub-pathways.

Figures

Figure 1: Addressing Healthcare Service Reform Goals (Adapted from Pickels et al., 2008)

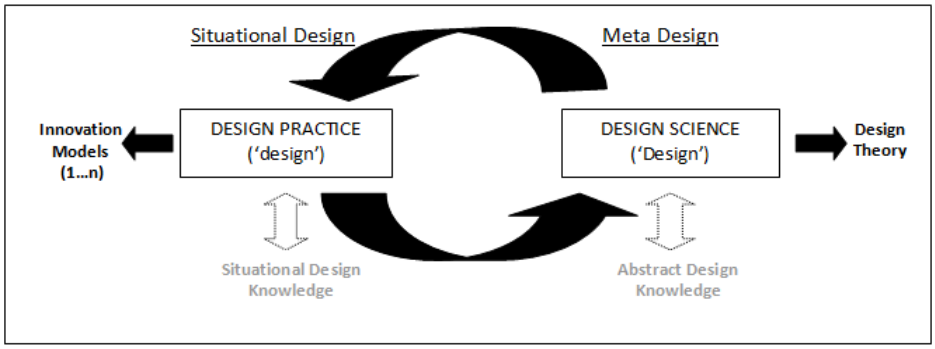

Figure 2: Our approach to design research (O'Raghallaigh et al., 2011)

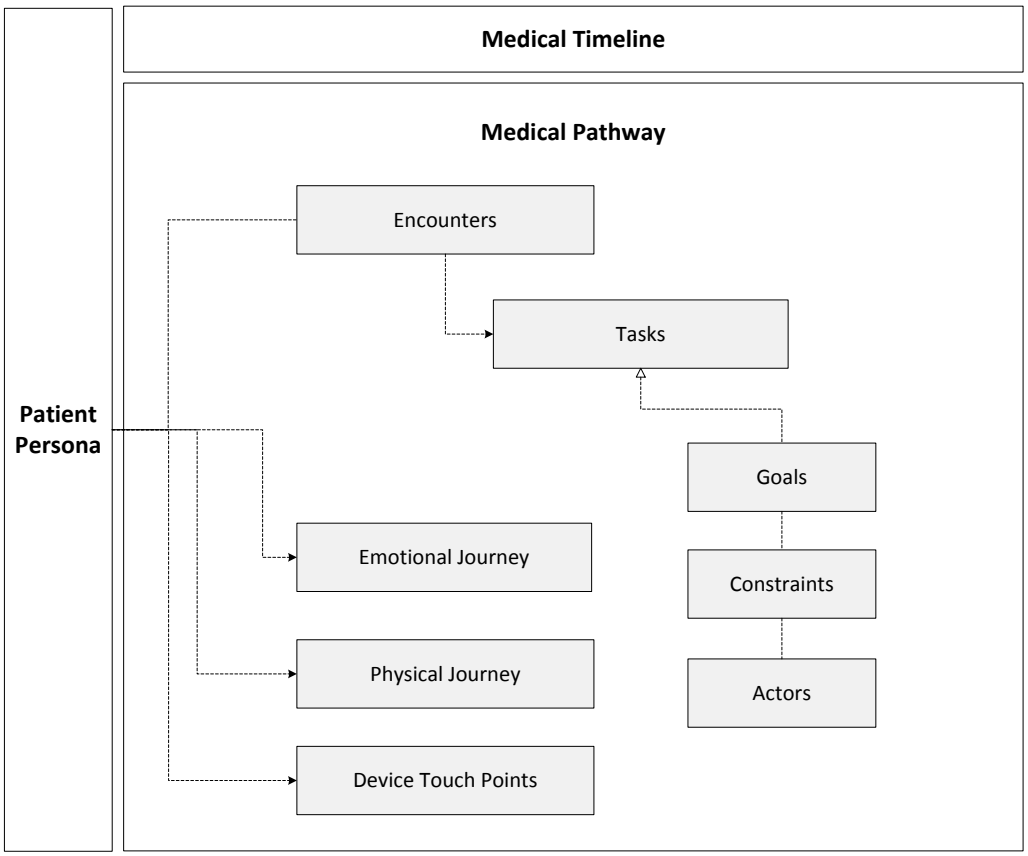

Figure 3: Patient Journey Map Ontology

Name

Age:

Occupation:

Family and marital status:

Risk profile:

Summary of journey:

Patient Journey Map

		Timeline	Week n	Week n+1	Week n+2	Week n+3	Week n+4	Week n+5	Week n+6
Emotional Journey									
Physical Journey									
Device Touch Points									
Encounters	Home								
	GP Clinic								
	Antenatal Day Clinic								
	Early pregnancy / fetal assessment clinic								
	Emergency Room								
	Maternity Ward								
Tasks	Secretary								
	Doctor (registrar, consultant)								
	Midwife								
	Clinical Researcher								
	GP								
	Expectant mother								
Safety and Governance									

Figure 4: Base Patient Journey Map Template